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ABSTRACT

An instrument is presented for recording and analyzing student and teacher behavior in laboratory or activity-centered vocational education classrooms. The instrument uses categories of behavior, such as: (1) asks extended thought questions, (2) shows or illustrates, and (3) management of lesson, for teachers; and categories such as: (1) asks questions, (2) reads lesson-related material, and (3) gets supplies or moves around the room, for student behavior. The categories are recorded using single-letter codes, along with codes to indicate to whom the behavior is being directed and the sex of the person to whom the behavior is being directed. This document describes the development and validation of the instrument, and gives descriptions of and rules for use of the categories. (BB)

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Science Laboratory Interaction Categories (SLIC): An Instrument to Observe and Analyze the Various Parameters of Activity-Centered and Vocational Education Classrooms

by

William C. Kyle, Jr., John E. Penick, James A. Shymansky

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Science Laboratory Interaction Categories (SLIC): An Instrument to Observe and Analyze the Various Parameters of Activity-Centered and Vocational Education Classrooms

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INTRODUCTION

The traditional method of measuring the effectiveness of a science program in terms of outcomes by means of administering tests based upon the scientific facts presented often neglect the affective elements of the science program or curricula; and, thus, may not adequately measure the goals established by recent curriculum designers. Answering the question of "what is really going on in the science classroom?" and, "how do the new curricula and objectives affect the daily activities and behaviors of teachers and students?" has been given very little attention (Stake, 1967).

In order to be able to make objective instructor and student evaluations, we must be cognizant of the behaviors which are being exhibited in the classroom. Objective, detailed, quantitative descriptions of instructor-student interactions in science classrooms and laboratories can now be obtained by systematic observational techniques using interaction analysis. An important area of research is the determination of functional relationships among four major classes of variables: antecedents of science classroom and laboratory behavior, instructor's classroom and laboratory behavior, student's classroom and laboratory behavior, and outcomes of classroom and laboratory behavior. Further, and heretofore gross measures of student learning must be replaced by increasingly sophisticated measures to provide answers to highly specific questions that can be asked on the basis of information available from interaction analysis. "Interaction analysis provides a description of what is and not a prescription of what ought to be" (Parakh, 1968, p. 847).

Systematic observation of classroom behavior is widely used in research on teaching. In the last fifteen to twenty years, major emphasis regarding classroom interaction analysis has been in the realm of science education. Evans (1973) reports that the use of systematic observation of classroom behavior dates back to 1914 when Ernest Horn developed a system for observing and coding behavior. Coding refers to the systematic and objective classifying and recording of teacher or student behaviors. Systems for observing teacher-student interactions can be grouped into three categories: cognitive behavior (intellectual activity in the classroom); affective behavior (socio-emotional behavior); and, psychomotor (multidimentional). Shymansky (1972) justifies the use of classroom interaction analysis as a form of assessment because:

> . . .so many things go on in a classroom that cannot be measured by existing testing procedures, a strong case exists for using direct classroom observational data in any study of classroom conditions. (p.2)

Investigators have used systematic observation of classroom behavior data in a number of ways to investigate teacher-student behavior. In the late 1920's, Barr (1931) identified criteria for teacher effectiveness; he also reports that in 1912, Romiett Stevens studied the question as a measure of efficiency of instruction. Anderson et al. (1946a, b) studied classroom climate via teacher-student contacts. Withal (1951) assessed the socio-emotional climate in a learning situation, while Flanders' (1969) objective was to obtain a greater understanding of the teacher's role in the classroom, the control the teacher provides while teaching, and patterns of teacher influence in classroom management. Bellack et al. (1963, 1966) described patterned processes of verbal

interactions that characterize classrooms and Smith and Meux (1962) attempted to divide verbal teaching behavior into pedagogically significant units, and to analyze these units in meaningful ways.

PROCEDURES

Each of the following will be discussed individually in this section:

A. Development of the Science Laboratory Interaction Categories (SLIC) -- Teacher and Student Versions

   1. Instrument validation

   2. Description of the coding instrument

B. Laboratory Observer Training Procedures

Development of the Science Laboratory Interaction Categories

The Science Laboratory Interaction Categories (SLIC) Teacher Version (Shymansky, Penick, Kelsey and Foster. 1976) (Table 1), and Student Version (Penick, Shymansky, Filkins and Kyle, 1976) (Table 2), were originally developed to objectively and systematically collect data on selected aspects of instructor and student behaviors in college science laboratories (or, any other activity oriented classroom setting). After an intensive review of Mirrors for Behavior III (Simon and Boyer, 1974) and other sources, it was evident that in order to competently observe and analyze the various parameters of college science laboratories, it would be necessary to develop a system specifically designed for such an analysis. Unfortunately, interaction analysis systems capable

of providing both quantifiable and reasonable feedback on instruction in college science laboratories, or simply science laboratories, are not abundant in the literature or easily developed.

Instrument Validation

During the developmental process of the Teacher and Student versions of SLIC, each of the authors spent a considerable amount of time in science laboratories assessing the type behaviors which were characteristic of the individual college science laboratories. When the initial system was developed, trial observations were made in science laboratories. It was through these trial observations that each of the individual categories was defined more specifically, refined, or expanded. Observations were made on a daily basis and conferences were held on a regular basis to discuss the observational data and to establish validity of the instruments. Once the ground rules were established for both the Teacher and Student versions (see Appendix A and Appendix B respectively), and all of those involved were satisfied with the behaviors which each category represented, observational data were collected from each of five science disciplines in an original study.

SLIC can provide frequencies of instructor and student behavior as well as patterns of behavior. In addition, these data can provide systematic and objective feedback to instructors intent on analyzing and improving their teaching effectiveness in the science laboratory; or, to department chairpersons who may be interested in knowing exactly what instructor behaviors are present in their laboratories.

TABLE 1

SCIENCE LABORATORY INTERACTION CATEGORIES (SLIC) - TEACHER*

X -- Asks extended thought questions; requires students to synthesize ideas; includes questions designed to elicit predictions, hypotheses, explanations, or evaluations.

Q -- Asks factual recall questions; no student synthesis required; includes questions asked for descriptions of what was done.

D -- Demonstrates procedure; any teacher manipulation intended to tell the student what to do or how to do an activity.

G -- Gives directions; verbal behaviors which tell the student what to do or how to do an activity; includes rhetorical questions.

S -- Shows, illustrates; any teacher manipulation of equipment done for the purpose of transmitting non-directive information (does not tell student what to do or how to do an activity).

T -- Transmits information; verbally transmitted non-directive information without use of manipulative materials.

P -- Positive reinforcement; positive evaluation of behavior.

N -- Negative Comment or Behavior; negative evaluation of behavior.

B -- Active observation; receiving information from the student through the direct manipulation of or reference to material or objects.

A -- Acknowledges student behavior; non-evaluative statements or gestures used to indicate attentiveness to student behavior; includes repeating or rephrasing student responses.

L -- Listens to students; receiving information from student through discourse directed at the teacher.

O -- Passive observation; watching or listening to students in situations where teacher is not directly or actively involved.

R -- Reads and/or writes; any lesson-related reading or writing done by the teacher, with or without students directly involved.

M -- Management of lesson; management or clerical activity related to the administration of the lesson; includes getting supplies, making assignments, etc.

Z -- Non-lesson-related behaviors; any teacher behavior which does not facilitate the activities or lesson taught.

* Developed by J. A. Shymansky, J. E. Penick, L. J. Kelsey, G. W. Foster; The Science Education Center, The University of Iowa, Iowa City, Iowa, 1976.

TABLE 2

SCIENCE LABORATORY INTERACTION CATEGORIES (SLIC) - STUDENT*

S -- Shows; manipulating materials with the purpose of transmitting information to teacher or student; includes showing how to do something as well as demonstrating the results of doing something.

E -- Manipulates apparatus, observes activity; experimenting, manipulating equipment, observing experiment in progress; other activity with lesson-related non-written materials.

T -- Transmits information; conveying ideas, thoughts, questions without manipulating equipment. Includes giving directions, feedback, answering questions, or other behavior which transmits information. Includes rhetorical questions.

Q -- Ask questions; any attempt to gather information verbally from teacher or students.

L -- Listens; active behavior of receiving information from teacher or students.

O -- Observes; passive behavior allowing student to watch actions of teacher or students. Includes listening to conversations in which the subject is not directly involved.

R -- Reads lesson-related material; any reading related to the lesson or course goals. Includes notes that have been written by the student; notes written by another student; a textbook or lab manual.

W -- Writes notes or records data; note taking, recording of data, answering of questions, or other writing directly related to the lesson. Does not involve transmitting information immediately to another person.

M -- Gets supplies, moves around the room; moving around the room in a purposeful fashion, getting supplies, putting away materials, or other mobile activities which facilitate the lesson.

Z -- Non-lesson-related behavior; behavior which does not facilitate the goals of the particular course or lesson, including interactive as well as non-interactive behaviors.

* Developed by J. E. Penick, J. A. Shymansky, K. M. Filkins, W. C. Kyle, Jr.; The Science Education Center, The University of Iowa, Iowa City, Iowa, 1976.

Description of the Coding Instrument

As with any interaction analysis system, an understanding of the overall organization of the SLIC system will facilitate its use in coding instructor and student behaviors. This system is designed for use in science laboratory or activity-centered settings in which manipulative materials play a major role in the instruction-learning environment. The SLIC system is least discriminating in traditional classroom environments where lecture-demonstration techniques are used most frequently. As instruction becomes dominated by the pure didactic technique, many of the SLIC behaviors become non-functional.

Using the SLIC system, it is preferable to collect data directly from the laboratory or classroom setting, although behavior may be coded from video tapes. Observers using the SLIC system code the behaviors of instructors or students every three seconds (unless there is a change of behavior sooner) using codes representing three dimensions of the interaction. The three dimensions are:

1. What is the specific nature of the behavior being exhibited by the instructor or student? (manipulates apparatus, transmits information, reads, etc.);
2. To whom is a specific behavior being directed? (to an instructor or to a student, and at how many individuals is the interaction being directed); and,
3. The sex of the student or instructor to whom the behavior is being directed (same sex, opposite sex, or mixed group if the behavior is directed at two or more individuals of opposite sex).

Complete descriptions of the individual behaviors and ground rules for using the Science Laboratory Interaction Categories - Teacher and Student versions are presented in Appendices A and B, respectively.

A sample coding sheet is presented in Figure 1 illustrating a two-minute coding sequence of a student observation. The sample observation begins with the student manipulating apparatus or observing an activity (E). The student for the first nine seconds is working on his own and thus, the second and third dimensions of the three dimension code contain an asterisk (*). In the fourth sequence the student listens (L) to one person (1) of the opposite sex (0). This sequence lasts for twelve seconds before the student transmits information (T) to the student he was listening to. The sex of the student being observed is known by comparing the interaction sequences with the sex of the instructor which is indicated in the upper right hand corner of the coding sheet. Persons using the Science Laboratory Interaction Categories should become familiar with the specific behaviors and ground rules (see Appendix A and B) through extensive training sessions prior to attempting to use the instrument for valid research studies. The following procedures used for the original study may be useful in getting to know the SLIC behaviors.

After the initial system was developed, each of the authors spent a considerable amount of time in science laboratories analyzing the type of behaviors which were characteristic of the individual college science laboratories. It was through these initial observations that questions regarding specific behaviors were raised and clarified. Discussion sessions were held in which extended clarifications and examples of instructor and student behaviors in each of the SLIC categories

FIGURE 1

Sample Student Coding Sheet

Date March 24, 1976 Day Wednesday Class 11:024 (L-D102)
Time (In) 8:45 (Out) 9:15 Teacher (M) F
Room 35 TH Number Ss 5 M 9 F

E	E	E	L	L	L	L	T	T	T
*	*	*	1	1	1	1	1	1	1
*	*	*	0	0	0	0	0	0	0

T	T	L	L	Q	Q	Q	Q	L	L
1	1	1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0	0	0

L	E	E	E	E	R	R	W	W	W
1	*	*	*	*	*	*	*	*	*
0	*	*	*	*	*	*	*	*	*

L	L	L	S	S	O	L	L	E	E
T	T	T	T	T	T	T	T	*	*
S	S	S	S	S	S	S	S	*	*

were given. Video tapes were used at his time to point out specific instances of the various instructor and student behavior categories.

The next phase of training consisted of each subgroup of observers going into live science laboratories to practice coding as a group. The three weeks of practice coding led to the establishment of ground rules and solidified the skills of the observers.

During these live observations, all of the student observers would select a student for observation. The instructor observers observed the instructor since most of the laboratory sections observed had but one instructor per section. After coding for approximately three minutes, the observer subgroups would leave the laboratory and compare codes. These mini-observations proved most effective in the final stages of the training procedures as well as providing validation of the SLIC instruments since all of the SLIC developers were also members of the coding teams.

The mini-observations lasted a period of three weeks. Each week a total group meeting was held and specific problems and changes in each version were thoroughly discussed. It was from information gathered in the mini-observations and the problems discussed at the group meetings that the final ground rules were established for both the Teacher and Student versions of the Science Laboratory Interaction Categories.

As was mentioned earlier in this section, the validity of the SLIC instrument was established by the authors during the developmental process. The fact that the observers using the instrument were also the developers establishes the instrument as being extremely valid, since all of the behavior definitions and ground rules were established by the observers.

Once the behavior definitions and ground rules were established the authors were concerned with accuracy and precision of measurement. The reliability of a measurement "is the statement which represents the various sources of error in the repeated measurement of a single phenomenon or the consistency in which an individual performs the same task over a period of time" (Brown and Webb, 1968, p. 37). Thus, the reliability in this context is a property of the meausre and not of the instrument. It needs to be established that an instrument itself is neither reliable nor unrelaible -- it is only when the instrument has been used to collect data that we can speak sensibly about reliability. It is obvious, however, that in order to collect reliable data with an observational instrument that the observational instrument must be valid, that is, the observation categories must be measuring what they purport to measure as established by the definitions and ground rules set forth by the developers. An instrument can produce scores or measures which are reliable or unreliable depending upon the manner in which the instrument is used, the subjects observed, the skill of the observer, and the number and length of observation periods (Rowley, 1976).

Each observer's score on a master-coded video tape was compared to the criterion code and an agreement index was computed using the Scott Coefficient, π (Flanders, 1965), where

$$\pi = \frac{P_o - P_e}{100 - P_e}.$$

In this formula, P_o is the proportion of agreement found by calculating the total percentage-of error between two observers and subtracting from 100,

$$P_o = 100 - \Sigma \text{ (differences)}.$$

P_e is the proportion of agreement expected by chance, which is found by squaring the mean proportion of tallies in each category, dividing the square by 100, and summing over all categories,

$$P_e = \Sigma\left(\frac{A + B}{2}\right)^2 / 100.$$

Thus, π can be expressed as the amount by which the tallies of two observers exceed chance agreement, divided by the amount by which perfect agreement exceeds chance. (See Table 3 for an example of the calculation of π)

In addition to inter-observer reliabilities, intra-observer reliability should be determined by having an observer code a taped segment twice with an appropriate time interval separating the two codings. By comparing these two sets of codes with the Scott technique, intra-observer reliability is calculated.

TABLE 3

Sample Calculation of Scott's Coefficient,

Behavior Category	Criterion Frequency (A)	Observer Frequency (B)	Difference (A-B)	$\frac{(\frac{A + b}{2})^2}{100}$
S	10	9	1	0.90
E	40	35	5	14.06
T	15	20	5	3.06
Q	25	22	3	5.52
L	10	14	4	1.44
			18	24.98

$P_o = 100 - 18 = 82$

$P_e = 24.98$

$\pi = \frac{P_o - P_e}{100 - P_e}$

$\pi = \frac{82 - 24.98}{100 - 24.98}$

$\pi = \frac{57.06}{75.06}$

$\pi = 0.76$

SUMMARY

> Many of the important and controversial issues in the education of teachers in the United States depend upon knowing in an accurate and detailed way just what constitutes "successful teaching" in the various kinds of positions and which characteristics of teachers make them successful . . . . The task of measuring teacher success is complicated by so many variables for which there are no satisfactory measures that the problem should become a major (concern). . . .
>
> T. Alexander et al. Yearbook XXIII of the National Society of College Teachers of Education

In the last fifteen to twenty years, major emphasis regarding classroom interaction analysis has been in the realm of science education with the intent of being able to access various characteristics of teacher behaviors which are concomitant with the effects on the educational outcomes of classroom teaching.

As suggested by Ivary and Neujahr (1970), to be able to access something, one must first be able to describe it accurately. Yeany (1975) concludes that "in order to understand one's own behaviors leads to control of them; therefore, in order to empirically describe and eventually access teaching activities, one needs an observation system" (p. 521). Ober (1967) maintains that an observation system can be any systematic technique used for identifying, classifying and/or quantifying specific teaching or learning activities. David G. Ryans (1964) states that with "respect to classroom observation methodology, it may be noted that reliability and validity of assessments made from direct observations generally were enhanced by:

1) attention to a limited number of relevant behavior dimensions for observation and assessment;

2) the provision of specific and unequivocal operational definitions of the characteristics to be assessed;

3) insuring that the observer was well acquainted with the behaviors to be assessed and with situations in which the behaviors frequently are manifest (acquaintance resulting from extended "training" involving use of the assessment instrument and procedure in actual classroom situations);

4) focusing of observer attention on the specified behaviors or characteristics to be assessed and carefully avoiding the influence of general impressions, unusual or dramatic behaviors, or inferences about what behaviors "might" occur in unobserved situations;

5) the immediate assessment of behavior during, or shortly following observation;

6) the independent assessment of each specified behavior;

7) recognition and suppression by the observer of personal biases relative to individuals or behaviors;

8) care on the part of the observer to avoid such rating biases as the central tendency error, the leniency error, and so on; and,

9) the replication of observations and assessments by independent, though similarly trained, observers." (p. 75)

Research relating to science classroom behavior has proven to be important. Yager (1962) and Zingaro and Collette (1968), reporting on college physical science laboratories, note that curricular evaluations lacking direct evidence that participating teachers have adopted desired behaviors in their classroom ignore a relevant variable. This position is supported by Young (1971) and Zingaro and Collette (1968) who report significant differences in student achievement appear related to the instructor doing the teaching, rather than any curricula or methods used.

Some research indicates that teachers behave significantly different in the classroom from their ideal or perceived classroom behavior (Barr, 1950; Flanders and Simon, 1969). Beam and Horvat (1975) studied both student and teacher perceptions of science classroom behaviors in grades seven through nine and observed what was actually going on in the classroom. Their results support the concept that as a group, science teachers were not able to perceive their own classroom behavior accurately and completely. Teachers seemingly focus on one dimension of classroom behavior while remaining unaware of the techniques they use for content development. Science teachers also "think they are running a more inquiry, indirect and student-talk oriented classroom than they actually are" (p. 341).

Anyone venturing into the field of systematic classroom interaction analysis should be charged with offering a good cause for a fresh attempt. The Science Laboratory Interaction Categories - Student (Penick et al., 1976) and the Science Laboratory Interaction Categories - Teacher (Shymansky et al., 1976) offer such a fresh attempt. Penick (1976) notes that:

> Laboratories are traditionally evaluated by means of examinations, either practical or written. The assumption being made here is that if students are learning the material presented in the laboratory then obviously the laboratory is being efficient in doing its job. The question of how students are learning never seems to be raised. Nor does the question of what students are doing while they are learning seem to be of any concern either. (p. 2)

In addition to these concerns, the quality of instruction in college science laboratories was also a concern of the original study. Assessment through the use of systematic and objective observation can provide teacher assistants at the college level, and teachers in general, with feedback regarding what is actually happening in the laboratory or classroom--specifically, the instructor and student behaviors. Shymansky (1977) maintains that:

> Accurate and detailed feedback concerning the events taking place in the lab sessions is an essential first step in analyzing and improving instruction. Only after instructors are aware of what they are doing in the laboratory instruction can they begin to think of ways of improving that instruction. (p. 3)

The Science Laboratory Interaction Categories (SLIC)--teacher and student versions--is offered as one method for providing needed feedback to instructors who desire to analyze and improve their teaching effectiveness in the college science laboratory, activity-centered classroom or vocational education classroom.

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* This bibliography provides reference information for sources cited throughout the paper, along with other selected references which may be of interest to the reader of this Technical Report.

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APPENDICES

APPENDIX A

SCIENCE LABORATORY INTERACTION CATEGORIES - TEACHER

(SLIC-Teacher)

Science Laboratory Interaction Categories - Teacher

(SLIC-Teacher)

James A. Shymansky
John E. Penick
Linda J. Kelsey
Gerald W. Foster

Observers using the Science Laboratory Interaction Categories for Teachers (SLIC-Teacher) code the behaviors of the laboratory teacher every three seconds with a three-place code representing three dimensions of the interaction. The three dimensions are:

1. What is the specific nature of the behavior being exhibited by the teacher (asking questions, manipulating equipment, demonstrating, etc.)?
2. To what number of students is the behavior being directed?
3. What is the sex of the student(s) with whom the teacher is interacting?

The second and third dimensions of SLIC-Teacher can be varied or eliminated at the option of the user.

SLIC is designed for collecting data from direct observations of teacher behaviors, but it may also be used for coding from videotaped laboratory sessions. Computer programs designed to provide pattern analysis as well as other analyses have been developed and are available.

SCIENCE LABORATORY INTERACTION CATEGORIES - TEACHER (SLIC-Teacher)

Subject of Observation:	Teacher only
Number of Subjects Observed:	One only
Collection Methods Reported:	Live (no special equipment needed)
Category Dimensions of the System:	Affective
	Cognitive
	Activity
	Sociological Structure
	Size of group at which behavior is directed
	Sex of group at which behavior is directed
Settings in Which Used:	Classroom, any content
	Classroom, for specific subject such as science laboratory classroom
Coding Units:	Category Change
	Time Unit
Collecting and Coding Personnel Needed:	One person only
Uses Reported by Authors:	Research
	Training
	Evaluation

CATEGORIES FOR

SCIENCE LABORATORY INTERACTION CATEGORIES

(SLIC) - Teacher

X -- Asks extended thought questions

Q -- Asks factual recall questions

D -- Demonstrates procedure

G -- Gives directions

S -- Shows, illustrates

T -- Transmits information

P -- Positive response to student

N -- Negative response to student

B -- Active observation

A -- Acknowledges student behavior

L -- Listens to students

O -- Passive observation

R -- Reads/writes material

M -- Gets supplies

Z -- Non-lesson behavior

The Three Dimensions of the Science

Laboratory Interaction Categories - Teacher

Number of recipients dimension:

The second dimension of the three-place code represents the number of people to whom the behavior is directed. When the teacher is making a conscious effort to interact with nobody, the code is 0; when he is directing his behavior towards the entire class, the code is L. If the exact number of recipients of the teacher behavior is discernible, the second code takes on a value from 1 to 9.

Sex dimension:

The third dimension indicates the sex of the person(s) to whom the teacher behavior is directed. The categories S (same sex), O (opposite sex) and M (mixed group) relate the sex of the students to that of the teacher. When the teacher is not interacting with any students (second-place code 0), the third code is left blank or marked *.

Behavior dimension:

X --Asks extended thought questions. Any questions which require students to synthesize ideas -- questions designed to elicit student predictions, hypotheses, explanations, or evaluation. Student responses to such questions may be verbal or non-verbal (the student may give a demonstration), long or short. Teacher statements leading to the question are included in this category.

Q --Asks factual recall questions. No student synthesis is required to answer these questions; the questions are designed to elicit the recall of factual information or descriptions of what was done or what happened.

D --Demonstrates procedure. The category includes teacher manipulation of equipment to show the student what to do or how to perform an activity and situations in which the teacher actually performs the activity for the student.

G --Gives directions. Rhetorical questions to redirect student behavior and telling the student what to do or how to perform an activity are included in this category.

S --Shows, illustrates. These teachers behaviors involve the manipulation of equipment for the purpose of transmitting non-directive information to the students -- manipulation that is not designed to tell students what to do or how to perform an activity. Included in this category are teacher use of graphs, models, diagrams, blackboard drawings, etc., to transmit information or stimulate thought.

T --Transmits information. The teacher attempts to verbally convey non-directive information to students without reference to or use of manipulative material or live equipment. The category includes non-evaluative teacher responses to student questions and reading or writing non-directive information for student use.

P --Positive response to student. Any positive reinforcement of student behavior that is more than informational. "That's very good", but not "I see you've completed that activity" (coded as A).

N --Negative response to student. Teacher's negative evaluation of a student behavior or student comment, and teacher's sarcasm.

B --Active observation. The teacher receives information from the student through the direct manipulation of, or reference to, a set of materials or objects. Either the student or the teacher can be doing the manipulation, but the manipulation must facilitate the student's communication to the teacher.

A --Acknowledgement of student behavior. Statements or gestures (mm hm, head shaking, non-evaluative "okay") to indicate attentiveness to student behavior; rephrasing or repetition of student responses.

L --Listens to students. The teacher is an active participant in the conversation; he receives information from the students through discourse directed at him or meant to include him.

O --Passive observation. Teacher behaviors which facilitate watching or listening to students in situations where teaching is not actively involved. Roaming around the room and scanning group or individual activities fall into this category.

R --Reads or writes. Any lesson-related reading or writing done by the teacher, whether or not it involves interaction with students.

M --Gets supplies. Procurement of materials or setting up equipment for another laboratory lesson or activity.

Z --Non-lesson-related behavior. Socializing with student on non-lesson-related topics, or any other teacher behavior which does not facilitate the activities or lesson being taught.

Ground Rules for Using SLIC-Teacher

As with any system, an understanding of the overall organization of the SLIC system will facilitate its use in coding teacher behavior. The system is designed primarily for use in activity-oriented science classrooms; situations in which manipulative materials play a major role in the instruction. However, the system can be used equally well in other activity-centered classrooms such as art and most vocational education classrooms. The SLIC-Teacher system is least discriminating in traditional classroom environments using lecture-demonstration strategies. Many of the SLIC teacher behaviors become non-functional as the instruction moves in the direction of the pure didactic technique.

The fifteen individual categories of teacher behavior in the SLIC system's primary dimension represent the fine structure detail of six broader strategies of teaching found in many classrooms. These six broad strategies are:

1. Asking Questions;
2. Giving Directions;
3. Transmitting Information;
4. Providing Feedback;
5. Observing Students;
6. Administering Program.

Because the materials and equipment offer an alternative to purely verbal instruction in a science laboratory, several of the six

Ground Rules

broad strategies can be further divided to reflect this use of these materials in a manipulative strategy. For example, a teaching strategy involving the giving of directions is generally thought of in terms of verbal behavior -- telling what to do or how to do something; however, the presence of equipment makes it possible for the teacher to give direction nonverbally through the manipulation of the equipment. Similarly, the transmission of information in a science setting can be accomplished both verbally and nonverbally if equipment and materials are available. A teacher can lecture about falling bodies or can illustrate the phenomenon. Hence, wherever possible in the SLIC system, teacher behaviors are divided to reflect the active involvement of materials in the strategy or the lack thereof. The following groups of behaviors represent this division:

Categories D, G

Categories S, T

Categories B, A, L, O

As a final note, the position of the above behaviors in the SLIC system is significant in that the active category (the one in which the materials or equipment play a role in the interaction) appears first in the listing. This positioning establishes a useful ground rule when coding. In the event that two categories appear to be occurring simultaneously, the behavior appearing first in the category listing should be recorded.

APPENDIX B

SCIENCE LABORATORY INTERACTION CATEGORIES - STUDENT

(SLIC-Student)

Science Laboratory Interaction Categories - Student

(SLIC-Student)

John E. Penick
James A. Shymansky
Kathleen M. Filkins
William C. Kyle, Jr.

Observers using the Science Laboratory Interaction Categories (SLIC) for Students (SLIC-Students) code the behaviors of students in a laboratory every three seconds with a three-place code representing three dimensions of the interaction. The three dimensions are:

1. What is the specific nature of the behavior being exhibited by the student (manipulates apparatus, asks questions, reads, etc.)?
2. To whom is the specific behavior being directed (to a teacher or to another student and at how many individuals is the interaction being directed)?
3. What is the sex of the student or teacher to whom the behaviors are being directed?

The second and third dimensions of SLIC can be varied or eliminated at the option of the user. SLIC is designed for collecting data from direct observations although behavior may be coded from video tapes of laboratory settings. Computer programs designed to provide pattern analyses as well as other analyses have been developed and are available.

SCIENCE LABORATORY INTERACTION CATEGORIES - STUDENT (SLIC-Student)

Subject of Observation:	Student only
Number of Subjects Observed:	One only
Collection Methods Reported:	Live (no special equipment needed)
Category Dimensions of the System:	Affective
	Cognitive
	Activity
	Sociological Structure
	Size of group at which behavior is directed
	Sex of group at which behavior is directed
Settings in Which Used:	Classroom, any content
	Classroom, for specific subject such as science laboratory classroom
Coding Units:	Category Change
	Time Unit
Collecting and Coding Personnel Needed:	One person only
Uses Reported by Authors:	Research
	Training
	Evaluation

CATEGORIES FOR

SCIENCE LABORATORY INTERACTION CATEGORIES

(SLIC) - Student

S -- Shows

E -- Manipulates apparatus, observes activity

T -- Transmits information

Q -- Asks questions

L -- Listens

O -- Observes

R -- Reads lesson-related material

W -- Writes notes or records data

M -- Gets supplies, moves around room

Z -- Non-lesson-related behavior

The Three Dimensions of the Science
Laboratory Interaction Categories - Student

Number of recipients dimension:

The second dimension of the three-place code in SLIC represents whether the student is interacting with a teacher or with another student. This dimension takes on a value of T if the student is interacting with a teacher or a value from 0 (student is interacting with no one) to L (indicating an interaction directed at the total group of students). Thus, if the exact number of student recipients is discernable in the interaction, the specific value from 1 to 9 may be assigned in the second-place code.

Sex of recipient dimension:

The third dimension of the SLIC system indicates the sex of the person or persons to whom the specific interactions are directed. The categories, same sex (S), opposite sex (O), and mixed group (M) refer to the sex of the recipients relative to that of the student being coded. In those instances where the student is not interacting with any students, indicated by a second-place code of 0, the third code is left blank, or marked with an asterisk.

Behavior dimension:

S --Shows. This category includes manipulating materials for the purpose of transmitting information to the teacher or to another student. It also includes showing how to do something as well as demonstrating the result of doing something. It may be considered to be a category "S" when a student is holding an item in hand and talking about it, when merely pointing to it, or when the student uses motions to graphically depict something.

E --Manipulates apparatus, observes activity. This category applies when the student is experimenting, manipulating equipment or observing an experiment in progress, as well as when doing any other activity with non-written materials which are a part of the lesson. It's important to note that it may involve just observing materials that are part of an activity without any actual manipulation of materials.

T --Transmits information. Transmitting is a behavior which conveys ideas, thoughts, or questions, but does not include manipulating the equipment. This behavior includes giving directions, giving feedback, answering questions, or any other behavior which is designed to transmit information to another individual whether teacher or student. This category also includes rhetorical questions - questions designed to give rather than collect information.

Q --Ask questions. Asking a question is an attempt to verbally gather information from either the teacher or other students. In the SLIC categories for students, no differentiation is made between types of questions. Rhetorical questions are not included in this category. Instead they are coded as "T".

L --Listens to teacher or students. Listening involves receiving information from either the teacher or other students through discourse directed at the student being observed. This is usually thought to be an active behavior as opposed to a passive behavior. Passive observing should be coded as "O" (observes).

O --Observes. Observing is a behavior which allows the student to watch the actions of the teacher, a student, or a group of students. "O" includes listening to a conversation in which the observed subject is not directly involved. If in doubt about the active involvement of the individual, code as "L", the more active category.

R --Reads lesson-related material. This category refers to any reading which is related to the lesson or course goals. It may be notes that have been written by the student, notes written by another student, a text book or a lab manual.

W --Writes notes or records data. This behavior involves note taking, recording of data, answering of questions, or other writing which is directly related to the lesson. If this writing is being done for the purpose of transmitting information immediately to another student, it would be coded as a "T" - Transmits information. Category "W" is designed to be used when the student is writing notes for personal use or as part of an assignment.

M --Gets supplies, moves around room. Moving around the room in a purposeful fashion, getting supplies, putting away materials, or other mobile activities which facilitate the lesson are coded as "M".

Z --Non-lesson-related behavior. This category includes any behavior which does not facilitate the goals of the particular course or lesson. This includes interactive, as well as non-interactive behaviors. If the student is involved in a non-lesson-related conversation while experimenting, alternate code between "Z" and "E", or with whatever other category is being exhibited simultaneously with the non-lesson-related behavior. "Z" would not include interacting with another student about an activity which may be eventually part of the lesson. If in doubt about whether a behavior is non-lesson-related or not, code as the appropriate lesson-related category.

Ground Rules for Using SLIC-Student

As with any system, an understanding of the overall organization of the SLIC system will facilitate its use in coding student behavior. The system is designed primarily for use in activity-oriented science classrooms. That is, situations in which manipulative materials play a major role in the instruction. However, the system can be used equally well in other activity-centered classrooms, such as art and most vocational educational classrooms.

The SLIC student system is least discriminating in traditional classroom environments using lecture-demonstration strategies. In fact, many of the SLIC student behaviors become non-functional as the instruction moves in the direction of the pure didactic technique and students are spending most of their time listening, writing, or reading.

The ten categories of the SLIC student system can be further subdivided if more fine detail is desired. For instance, asking questions "Q", could be further divided into the type of question being asked, whether it was a question related to gathering instructions as to what to do, or whether the question was involved in finding out more information about something. A category such as "Transmits" could be divided into categories such as transmits voluntarily, transmits involuntarily, and so on. The ten categories as they are listed have been found to be very useful and have

Ground Rules

enough detail to make some fairly accurate assessments of what students are doing in a science laboratory situation.

The position of the ten SLIC student behaviors in the SLIC system is significant in that the more active category (or the one in which the materials or equipment play a role in the interaction) appear first in the listing. This positioning establishes a useful ground rule in coding. In the event that two categories appear to be occurring simultaneously, the behavior appearing first in the category listing should be recorded. An alternative to this can be to alternate codes when two things are happening simultaneously. An extension of this same ground rule says that if you can't discriminate between two behaviors, for instance, if you're not sure whether a student is listening or merely observing, then you code it as the higher of the two categories, that is, listens. As another example, if you aren't sure whether a student is merely manipulating an apparatus, or is manipulating in an attempt to show something, then you would code it as shows, the higher of the two categories.

This ground rule of coding something, an ambiguous something, as the higher of two categories, is generally a conservative strategy in that the active category is more than likely a more desirable behavior than the passive category.